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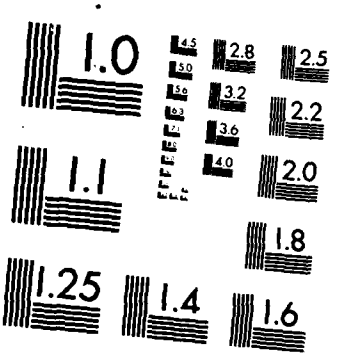

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This TOP describes a method for measuring the radar reflectivity characteristics of aircraft. It uses a rotating platform and various radar systems to obtain calibrated radar automatic gain control (AGC) values for each degree of aspect angle for the aircraft.

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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

AMSTE-RP-702-106
*Test Operations Procedure (TOP) 7-3-524 10 July 1986
AD No.

RADAR REFLECTIVITY

1. SCOPE. This TOP describes a method for measuring the radar reflectivity characteristics of aircraft. It uses a rotating platform and various radar systems to obtain calibrated radar Automatic Gain Control (AGC) values for each degree of aspect angle for the aircraft. The purpose of this test is to provide comparable values of radar reflectivity for Army aircraft at various radar frequencies and parameters for fixed positions and aspect angles on the aircraft. Data collected on each specific aircraft can be used to evaluate radar reflectivity characteristics of aircraft skin material, paint, and structural changes such as flat versus curved surfaces.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Item	Requirement
Test site	A clear level area of approximately two kilometers in length by one kilometer in width, with no trees or other obstructions, and having electrical power available for the tower and radar system(s).
Aircraft Test Tower	Tall enough to raise the aircraft above the ground clutter surrounding the test area with a line of sight clearance above surrounding vegetation from all radar locations.

*This TOP supersedes MTP 7-3-524, 1 September 1971.

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	A turntable of sufficient strength to hold, rotate, and rigidly support the test aircraft.
	Turntable rotation rate should not exceed 1/3 RPM.
	Turntable should have the capability of rotating the test aircraft to fixed aspect angles with an accuracy of one degree.
	Electrical power for the test aircraft.
Radar Maintenance Facility	Personnel with the appropriate MOS and training to maintain and operate the individual radar systems.
	Proper tools and test equipment to maintain the individual radar systems.
Crane	Capable of safely lifting the aircraft and placing it on the tower.
Aircraft Lifting Harness	Designed for the specific test aircraft.
Data Reduction Facility	Hardware and software required to reduce raw data into usable information and produce plots and listings for the final report.
	Security accreditation commensurate to the security level of the information to be processed.

2.2 Instrumentation

Item	Permissible Error of Measurement
Multi-Band Aircraft Tracking Radar(s)	Self-contained trailer or truck mounted systems which provide frequency coverage from .5 to 50 GHz.

	Both CW and pulse radars to obtain reflectivity measurements on as many types of radars as possible.
	Instrumented to collect AGC levels. AGC voltages should be digitized and recorded on magnetic tape along with a standard time reference such as International Range Instrumentation Group (IRIG) time.
	Automatic tracking radars.
Aircraft Test Tower	Instrumented to provide the azimuth angle of the turntable in relation to the same standard time reference used by the radar instrumentation.
	Calibration spheres and corner reflectors available for pre-test and post-test AGC checks.

3. REQUIRED TEST CONDITIONS.

3.1 General.

a. Consult TECOM Regulation 70-24[a] to formulate the test plan.

b. Become familiar with the test plans from previous radar reflectivity tests on similar aircraft.

c. Incorporate the proper safety precautions into all test procedures.[b,c]

d. Brief all personnel on the safety hazards involved with lifting an aircraft.

e. Brief all personnel on the hazards of electromagnetic radiation exposure.[d]

f. Use radiation hazard warning signs to mark the minimum safe personnel distance for each radar system.

g. Obtain radiated frequency authorizations for each radar system.

[a]Footnote letters match those in Appendix C.

h. Brief all personnel on appropriate security measures to be practiced during the test project.[e]

3.2 Facilities.

a. Ensure the test aircraft is properly installed on the turntable of the test tower.

b. Ensure all the required hardware and software are available to reduce the data to final form.

c. Ensure approved storage is available for classified information (documents, ADP media, etc.).

3.3 Instrumentation.

a. Calibrate the radar AGC voltage.

(1) Disconnect the antenna from the receiver.

(2) Connect a signal generator to the receiver at a point between the antenna and the receiver input.

(3) Adjust the signal generator for the frequency and pulse characteristics of the radar system.

(4) Set the output level to zero output.

(5) Record the AGC voltage.

(6) Increase the signal generator output until the AGC voltage changes by .1 volt.

(7) Record the AGC voltage and the generator output level.

(8) Repeat steps 6 and 7 until an increase in generator output does not cause a change in AGC voltage (AGC saturation).

(9) Using the gain of the antenna and the losses in the lineup to the signal generator connection, calculate the signal level required at the antenna to produce the same signal level at the receiver corresponding to the measured AGC voltage.

b. The AGC voltage should be checked before and after each test to ensure the AGC voltage has not changed more than ±3% of previous readings.

c. Point the antenna at the corner reflector and adjust the antenna position controls for maximum signal return on the radar.

d. Record the AGC voltage value.

e. Ensure all data collection systems are operational.

4. TEST PROCEDURES.

a. Develop a checklist to ensure all ground systems have been setup correctly and are operationally ready to support the test.

b. Prepare a data management plan that ensures all test data is properly collected, labeled and stored during the test.

c. Prepare a data reduction matrix for each test which shows the steps required to reduce the data to its final level.

d. Check the results of each test before continuing to ensure no critical data points were missed and to annotate known erroneous data.

e. Keep track of test funds expended and remaining for the test program. Monitor expenses on a weekly basis.

f. Maintain overall program control by:

(1) Monitoring the efforts of subordinates.

(2) Ensuring proper training is accomplished.

(3) Maintaining close coordination with all support activities.

(4) Ensuring all data is collected in accordance with the test procedures in the test plan.

5. DATA REQUIRED.

5.1 Reflectivity Measurements.

5.1.1 Procedures.

a. Calibrate the radar AGC voltage.

b. Baseline measurements (no aircraft on tower).

(1) Lock onto the top of the aircraft tower.

(2) Rotate the turntable at a rate which will allow a data collection rate of at least five samples per degree of rotation while maintaining automatic track with the radar.

(3) Collect data at the tower and at the radar.

(4) Rotate the turntable at least ten complete revolutions.

(5) Repeat steps 1 through 4 at least ten times.

c. Start the engine(s) on the aircraft (aircraft on tower). Run the engines at normal RPM.

d. Lock onto the aircraft with the radar system and place it in automatic track mode of operation.

e. Rotate the turntable at a rate which will allow a data collection rate of at least five samples per degree of rotation, while maintaining automatic track with the radar.

f. Rotate the turntable at least ten complete revolutions. In case the aircraft is rotated to a fixed aspect angle, the reflectivity is recorded as the radar footprint eliminates individual sections one at a time until the entire aircraft is covered.

g. Have the radar operator note anything peculiar, such as power interruptions or radar breaklock during the test.

h. Replace the radar with a radar of a different frequency band and repeat steps a. through g.

i. Accomplish the above procedures with at least one radar in each frequency band using horizontal, vertical, and circular antenna polarizations, if available.

j. If available, accomplish the above procedures with a CW radar to obtain measurements on all types of radars.

5.1.2 Data Required.

a. Time tagged radar AGC voltages.

b. Turntable time tagged azimuth angles.

c. Radar operator notes.

d. Radar data collection sheets.

6. DATA PRESENTATION.

6.1 Data Reduction. Perform the following for each polarization of each radar:

a. Merge the AGC voltages with the turntable angles using IRIG time for reference.

b. Combine all data into one degree cells.

c. Group all like cells.

6.2 Data Analysis.

a. Calculate the mean and standard deviations of the AGC voltages for each one degree cell.

b. Compare the mean AGC values with the AGC calibration results to determine the amount of fixed bias on the data.

c. Convert the AGC values to radar cross sections values using the reflector measurements of the calibrated sphere and corner reflectors.

6.3 Data Presentation.

a. Prepare a polar plot for each polarization of each radar.

b. Show the aircraft in the center with the mean AGC voltages and their respective standard deviations plotted in one degree increments with increasing values toward the outer edge of the plot.

c. Adjust the scale on the plot to best represent the data for each test condition.

d. Label the plot with the aircraft type, radar type, frequency, and distance from the aircraft to the radar.

e. Include the radar parameters, such as PRF, duty cycle, and effective radiated power, in the narrative discussion.

Recommended changes to this publication should be forwarded to Commander, U.S. Army Test and Evaluation Command, ATTN: AMSTE-TC-M, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, U.S. Army Aviation Development Test Activity, ATTN: STEBG-MP-P, Fort Rucker, AL 36362-5276. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22034-6145. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A

SAMPLE TEST OPERATIONS CHECKLIST

	Date-Initials
Project notebook initiated	_____
Test plan reviewed and test parameters established	_____
Test facility and support instrumentation scheduled for test period	_____
Instrumentation checked for proper functioning and appropriate calibrations	_____
Locks, interlocks and warning devices of test facility checked for proper operation	_____
Safety requirements accomplished and safety regulations posted at test facility	_____
Test personnel briefed on test requirements, special procedures and hazards	_____
Test performed and data recorded	_____
Data reduced and analyzed	_____
Test personnel briefed on test requirements special procedures, hazards and security requirements	_____

APPENDIX B

DATA COLLECTION SHEETS

RADAR DATA COLLECTION SHEET

Mission No.:_____ Start Time:_____ Stop Time:_____

Radar Type/Model No._____Band:_____

PRE-MISSION

Date:_____ Time:_____

Frequency:_____ PRF:_____

Pulsewidth:_____ Duty Cycle:_____

Effective Radiated Power:_____

Radar Instrumentation Checks

Boresight 88 Voltage:_____

IRIG Time Check:_____

POST-MISSION

Date:_____ Time:_____

Frequency:_____ PRF:_____

Pulse width:_____ Duty Cycle:_____

Effective Radiated Power:_____

Rada. Instrumentation Checks

Boresight AGC Voltage:_____

IRIG time Check:_____

Notes: classified as required.

APPENDIX C

REFERENCES

REFERENCES FOR INFORMATION ONLY

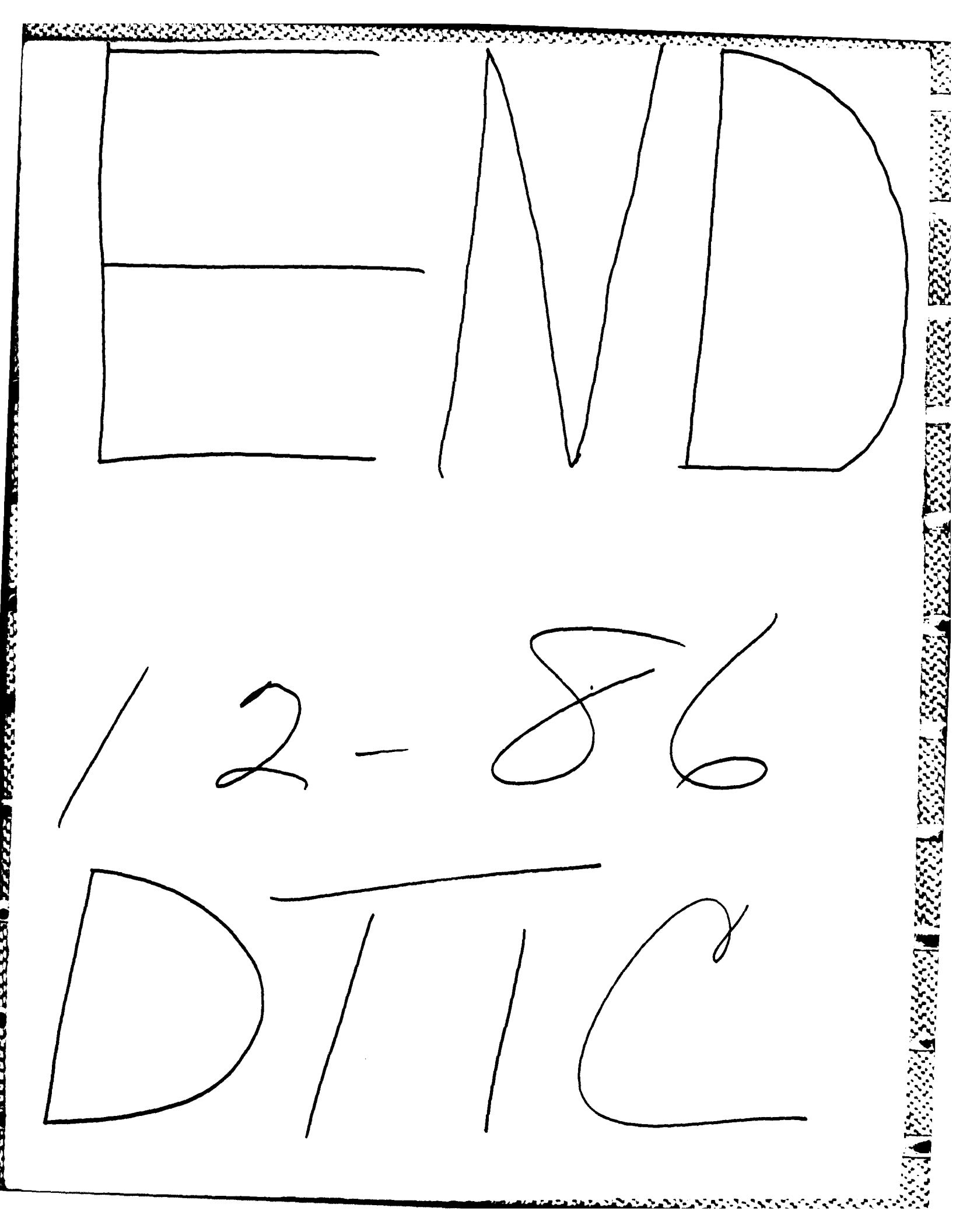
a. TECOM Regulation 70-24, Research and Development; Documenting Test Plans and Reports, June 1981.

b. TECOM Regulation 385-25, Radiation Protection, 3 July 1969.

c. Material Test Procedures 7-3-056, Safety, 18 January 1982.

d. TB MED 253, Control of Hazards to Health from Microwave and Radio Frequency Radiation and Ultrasound, 15 July 1980.

e. AR 380-5, Department of the Army Information Security Program, 15 February 1985.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